



Can we have our cake

and eat it too?

Presentation at EETD Seminar

26 Oct 2009

LBNL

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Menlo Energy Economics

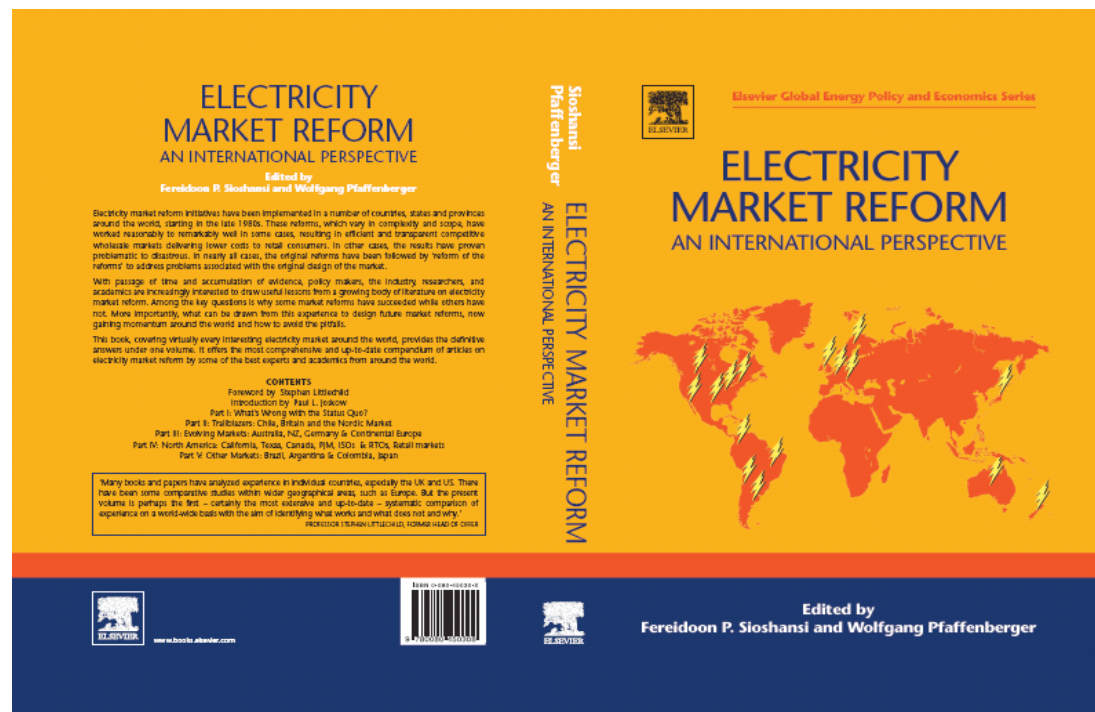
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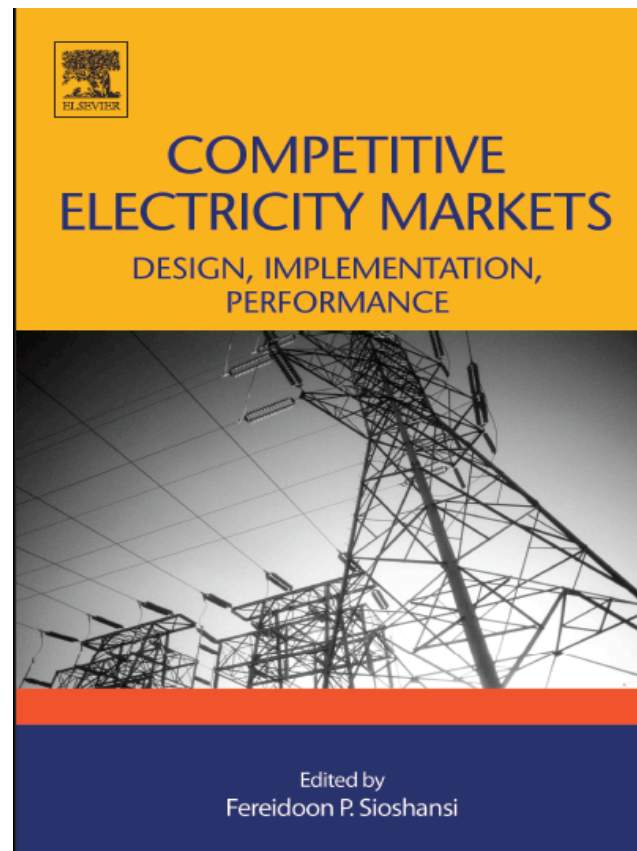
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Outline

- ◆ Context
- ◆ Current book project
- ◆ Ideas



Sequel book



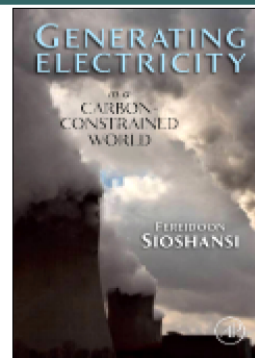
GENERATING ELECTRICITY

in a
CARBON-
CONSTRAINED
WORLD

FEREIDOON
SIOSHANSI



Hot off the press



Sept 2009 | Hardcover | 664 pp
List Price: \$135.00 USD
ISBN: 978-1-85617-655-2

Generating Electricity in a Carbon Constrained World

Edited by Fereidoon P. Sioshansi
Menlo Energy Economics

Coming in
Sept 2009!

ADDRESSING THE CLIMATE CHALLENGE

Climate change, among the most pressing problems of our time, is posing difficult challenges for policy makers globally. This book describes the various options to reduce the carbon footprint of the electric power sector, one of the main contributors to global greenhouse gas emissions.

KEY FEATURES

- Provides context for the carbon containment problem and describes different policy options to curb global greenhouse gas emissions
- Examines the pros and cons of various technical options for de-carbonizing power generation – covering renewable energy resources, nuclear, carbon capture and sequestration (CCS) and energy efficiency
- Includes case studies and initiatives to reduce carbon emissions from different parts of the world

"The book frames how the combined challenges of policy and technological choice are played out in diverse locations – with lessons for all" ... "To attempt such analysis at a global level is a daunting but wonderful undertaking, and Fereidoon Sioshansi and the contributing authors should be congratulated for a tremendous compendium of insights and experience from around the world. If you want a timely, diverse and global perspective on one of the great challenges of our time – read this book."

Professor Michael Grubb, Imperial College & Cambridge University

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Scholarly input

Generating Electricity in a Carbon Constrained World Edited by Fereidoon P. Sioshansi

The contributors to the book are renowned experts and scholars in their respective fields

Contents of the book

| | |
|---|--|
| Foreword Electricity generation in a carbon-constrained world Michael Grubb, Imperial College & Cambridge University | Chapter 9 Wind power Ryan Wiser, LBNL and Dr. Maureen Hand, NREL |
| Preface Reducing the carbon footprint: A multi-dimensional problem Wolfgang Pfaffenberger, Jacobs University Bremen | Chapter 10 Solar energy Paul Denholm, Eassan Drury, Robert Margolis, and Mark Mahor, NREL |
| Introduction The problem in context Fereidoon P. Sioshansi, Menlo Energy Economics | Chapter 11 Geothermal power: An emerging giant? Kenneth Williams |
| Chapter 1 The challenge of stabilizing world CO ₂ emissions: A bridge too far? Alan Moran, Inst. Public Affairs, Melbourne, Australia | Chapter 12 Hydro-electricity Lito Lizardo Araujo, CEPAL, Brazil, Luiz Pinguelli Rosa, COPPE/UFRJ, and Neilton Fidelis da Silva, Federal Center of Technological Education (CEFET) |
| Chapter 2 Carbon policies: Do they deliver in the long run? Emile Chappin, Gerard Dijkema and Laurens de Vries, Delft University of Technology | Chapter 13 Ontario: The road to off-coal is paved with speed bumps Peter Fraser and Roy Hrab, Ontario Energy Board |
| Chapter 3 Creating markets for tradable permits in the emerging carbon era Reiner Musier and Parviz Adib, APX | Chapter 14 Kicking the fossil fuel habit: New Zealand's case Geoff Bertram and Doug Glover Victoria Univ. Wellington, NZ |
| Chapter 4 Making it personal: Per capita carbon allowances? Tina Favre, Oxford University, Frede Hvalplund, Aalborg University and Niels I. Meyer, Tech University of Denmark | Chapter 15 Carrots and sticks: Will the British electricity industry measures up to the carbon challenge? Nigel Cornwall, Cornwall Energy Associates |
| Chapter 5 Addressing climate change: Global or local? Benjamin Sovacool, Virginia Tech and National University of Singapore and Marilyn A. Brown, Georgia Tech | Chapter 16 CO ₂ Regulations: the view of a European electricity company Jean-Michel Trochet, Jean-Paul Bouteau and Francois Daas, Electricite de France |
| Chapter 6 De-carbonizing Coal Klaus S. Lackner, Columbia Univ., Alissa Park, Columbia Univ. and Bruce Miller, Penn State Univ. | Chapter 17 Low Carbon Electricity Development in China: Opportunities and Challenges Joanna Lewis, Georgetown University, Zhang Xiliang and Qimin Chai, Institute of Energy and Environmental Economics, Tsinghua University, Beijing |
| Chapter 7 Nuclear energy Geoffrey Rothwell, Stanford Univ. and Rob Graber, EnergyPath Corp. | Chapter 18 California dreaming: The economics, politics and mechanics of meeting California's carbon mandate Gary Stern and Frank Harris, Southern California Edison Co. |
| Chapter 8 Energy efficiency: Potential, barriers & policies William Prindle, ICF International, Jay Zamikau, Frontier Associates & University of Texas, Austin & Erica Allis, United Nations Environment Program | Chapter 19 RTO's role in implementing US climate policy Udi Helman, CAISO, Harry Singh, Sempra Energy Trading and Paul Sotkiewicz, PJM Interconnection |

Conclusions

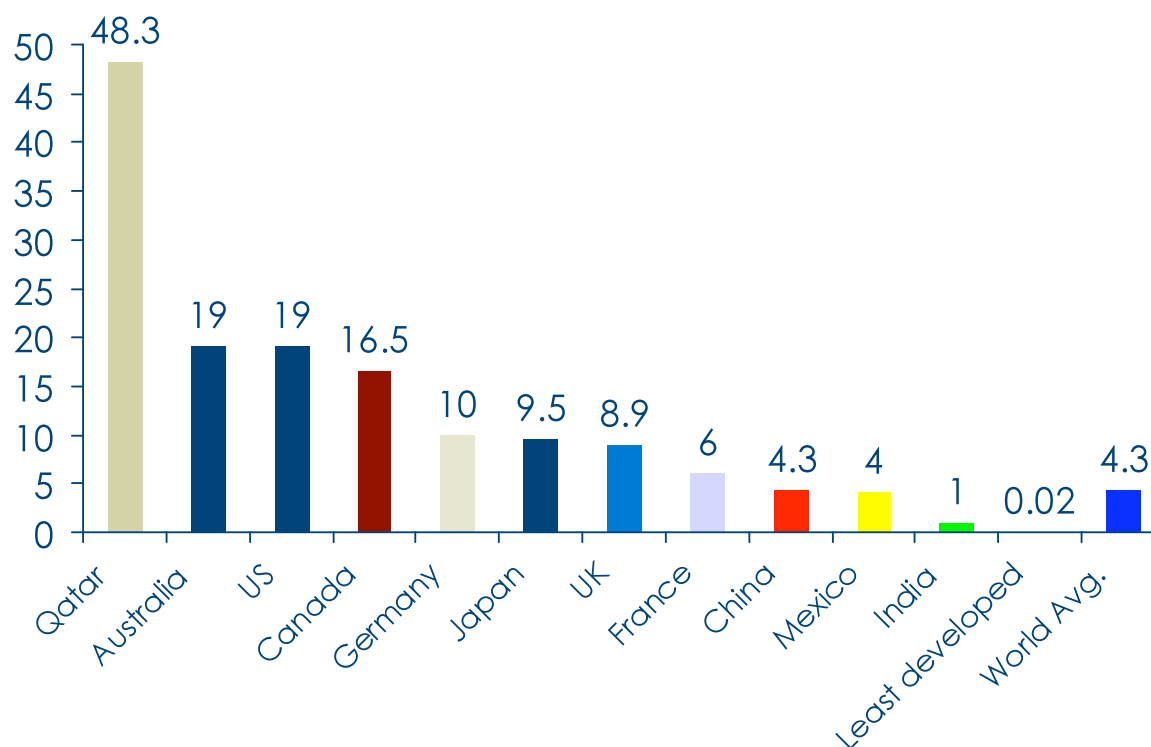
- ◆ No silver bullet, nor any combination of silver bullets
- ◆ Even if we can take all carbon out of electricity generation, climate change problem *not* resolved
- ◆ Ditto even if we stop emitting all carbon from all sources within OECD

No game changers

- ◆ Renewables
 - No panacea
- ◆ Nuclear
 - Great expectations/greater disappointment
- ◆ CCS
 - “S” as obstacle even if we can address “CC”
- ◆ Energy efficiency
 - Incremental gains insufficient

Already past 2 tonnes budget?

per capita carbon emissions, tons/cap/yr



Source: International Energy Agency

Personal insight

“As the chapters of this book make clear, **we cannot rely entirely on changes in the supply-side** of the equation to reduce the industry’s carbon footprint. Changes in the **demand-side** as well as changes in **energy consumption habits** – and perhaps more profoundly – **lifestyles changes** may ultimately be needed to address the carbon problem.”

Required reading

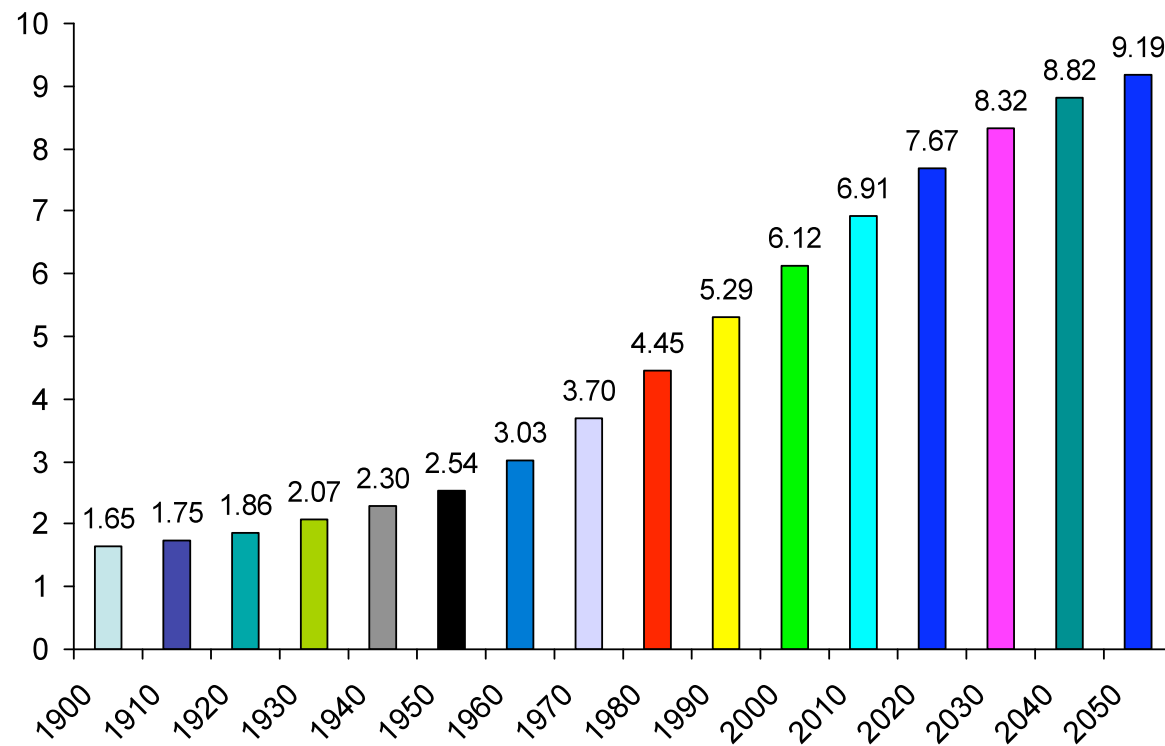
- ♦ Collapse – societies that live beyond their means don't survive
- ♦ \$20 per gallon – our entire economic system is predicated on artificially cheap & seemingly plentiful energy. If either of these conditions changes, the entire system collapses
- ♦ Sustainable *Energy without hot air* – current debate on energy, sustainability & climate change is mostly hot air compounded by mis-information, hyperbole and untruths
- ♦ Swiss 2000 Watt Society – incremental change is not sufficient
- ♦ Ted Trainer's "simpler way" – radical & potentially unpleasant lifestyle changes may be necessary

In need of overhaul?

- ◆ Current social, economic, political, business system based on outdated assumptions
 - Infinite natural resources, zero externality costs
 - Perpetual economic growth
 - Consumer-oriented culture
 - “Who ever owns more wins”
 - Big government, big/global business
 - Short-term, profit motivated

Global population growth

And the basic needs that go with it: Food, energy, water



Stick with status quo

- ◆ Work within existing, democratically-elected political system
 - Use current tools
 - Price signals, taxes, incentives, regulatory mechanisms
 - ◆ E.g., ETS under cap-and-trade regime
 - Rely on markets

Start a revolution

- ◆ Current system/mechanisms inadequate
- ◆ Incremental approach insufficient
- ◆ Status quo fundamentally incompatible with long-term sustainability– globally & equitably defined

Idea list

- ◆ Future energy scenarios
 - Technology comes to the rescue, again?
 - Diminishing marginal returns
- ◆ How many tanks to kill a fly?
 - What constitutes a “decent” standard of living?
 - How much energy does it take?
- ◆ Ethics of energy & carbon inequality
- ◆ Case for radical lifestyle change
 - Small-scale, self-sufficient & frugal – who would buy it?

How much do we really need?

Per capita electricity usage in selected states, kWh/yr
US Avg. 13,300 kWh/pa

| State | Per Capita Electricity Usage (kWh) | Ranking |
|----------------|------------------------------------|------------------|
| Wyoming | 26.208 | 50 th |
| North Carolina | 14.347 | 35 th |
| Oregon | 13.208 | 25 th |
| Illinois | 10.839 | 15 th |
| California | 6.818 | 1 st |

Source: California Energy Efficiency Potential Study, Vol. 1,
prepared by Itron Inc., et al, 24 May 06

Idea list, cont'd

- ◆ Sustainability
 - What does it entail?
 - How can it be achieved?
- ◆ Can we have it both ways?
 - Implications for bounded carbon budget
- ◆ Net zero energy buildings
 - Impact on tariffs with falling consumption
- ◆ Beyond the meter
- ◆ Renewable energy not green?
- ◆ Reversing the grid

From your pocket to gas tank

Missing price signal a huge obstacle



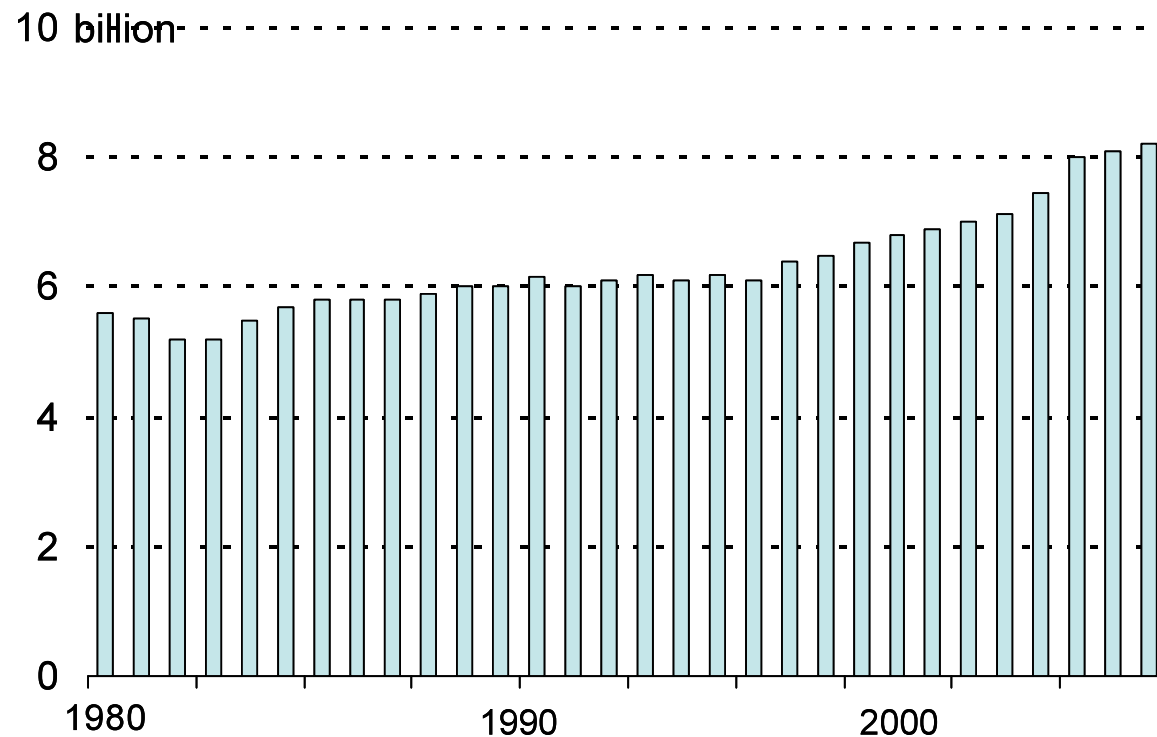
Of special interest

- ◆ Voluntary vs. mandatory?
- ◆ Why roof leak is different than duct leak?
- ◆ Rationing in peace time?
- ◆ Personal carbon allowances
- ◆ Smart pricing
- ◆ Raising public awareness
- ◆ Behavioral modifications
- ◆ Experimentation

Back up slides

Where to put all the carbon?

Global emissions of CO₂, Billion metric tons



Nuclear

A case of great expectations?

- ◆ Proponents have great hopes on nuclear
- ◆ Many believe it's the **only** viable option
- ◆ Nuclear can be a contributor but ...
 - Requires massive front-loaded investment
 - Takes good many years to build
 - Requires sophisticated technology
 - Massive effort just to maintain current share within OECD
 - For nuclear to replace coal **will be a push**
 - Globally, *"too many coal plants for nuclear to overcome"*
 - Not a message many want to hear

An aging fleet

Replacing existing nuclear fleet will be a challenge

| Country | # Operating Nuclear Units | Capacity of Operating Units (GWe) | % of Country Electricity | # Nuclear Units Under Construction |
|-------------|---------------------------|-----------------------------------|--------------------------|------------------------------------|
| U.S. | 104 | 100.5 | 19.8% | 0 |
| France | 59 | 63.2 | 78.6% | 1 |
| Japan | 56 | 47.9 | 26.4% | 2 |
| Russia | 31 | 21.7 | 15.5% | 5 |
| Germany | 17 | 20.3 | 27.5% | |
| South Korea | 20 | 16.8 | 35.9% | 3 |
| Ukraine | 15 | 13.1 | 47.9% | |
| Canada | 18 | 12.6 | 14.7% | |
| U.K. | 19 | 10.5 | 20.0% | |
| Sweden | 10 | 10.0 | 50.3% | |
| China | 11 | 8.6 | 2.3% | 6 |
| Belgium | 7 | 5.8 | 56.3% | |
| Taiwan | 6 | 4.9 | 18.8% | 2 |
| India | 17 | 3.7 | 2.4% | 5 |
| ROW* | 50 | 32.8 | 14.2 | 7 |
| Total | 440 | 372.4 | 15.7% | 31 |

Source: EPND

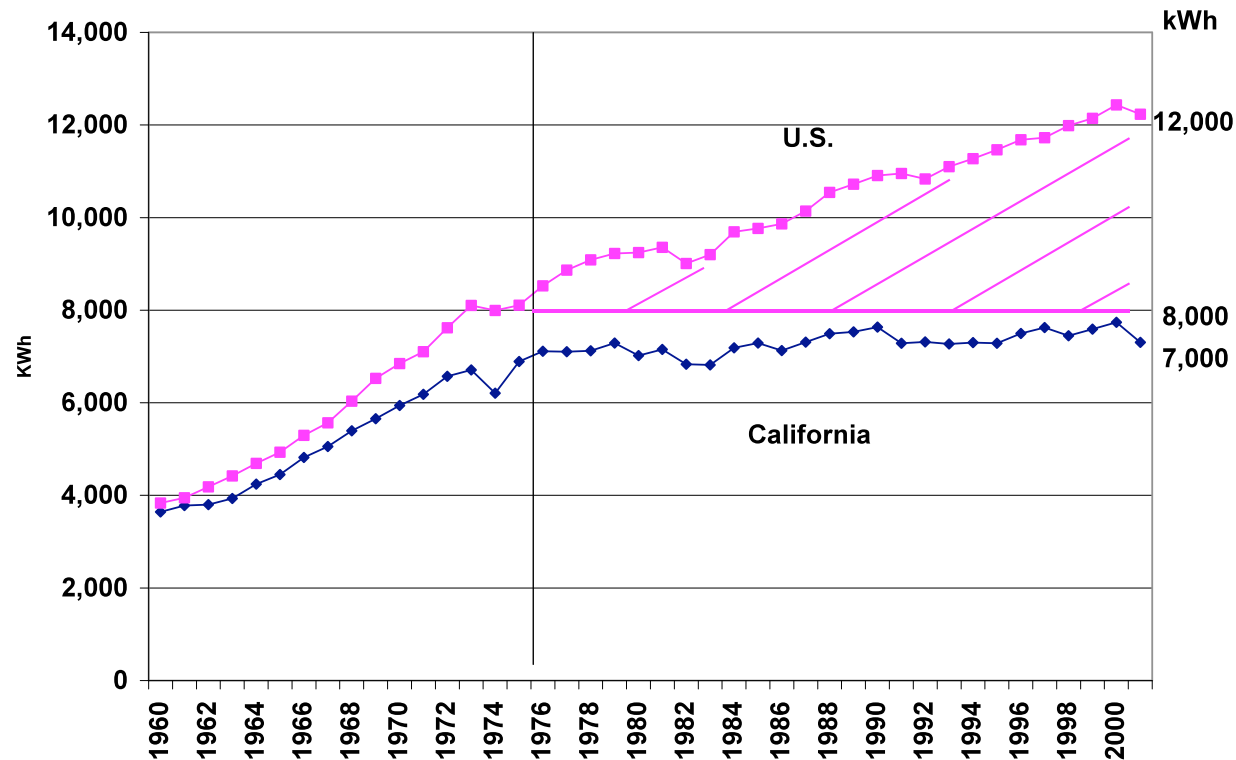
* ROW Operating Units: Argentina (2), Armenia (1), Brazil (2), Bulgaria (2), Czech Republic (6), Finland (4), Hungary (4), Lithuania(1), Mexico (2), Netherlands (1), Pakistan (2), Romania (2), Slovakia (5), Slovenia (1), South Africa (2), Spain (8), Switzerland (5)

ROW Construction Units: Argentina (1), Bulgaria (2), Finland (1), Iran (1), Slovakia (2)

Why can't we get by with less?

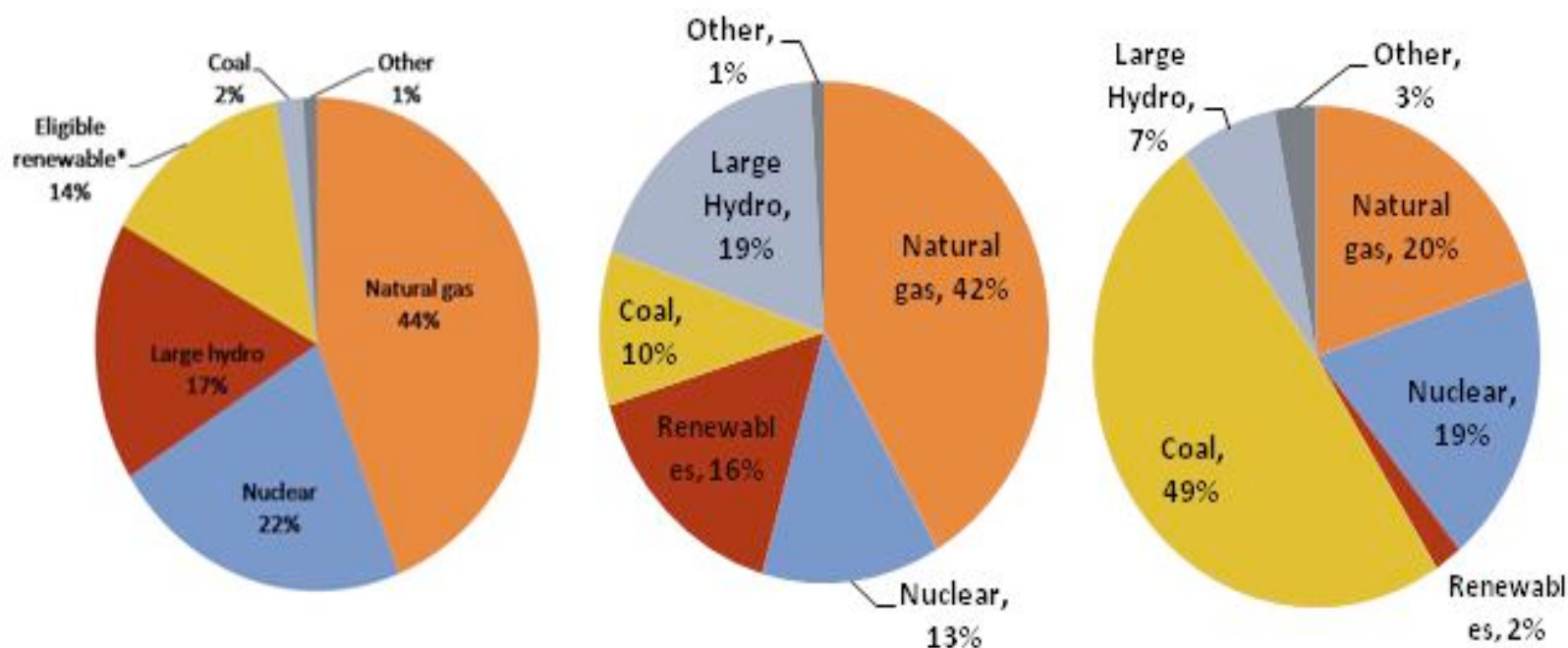
Per capita electricity consumption, kWh/yr

Total Electricity Use, per capita, 1960 - 2001



Low carbon & efficient

Electricity generation mix, PG&E (left), CA (middle) US (right)

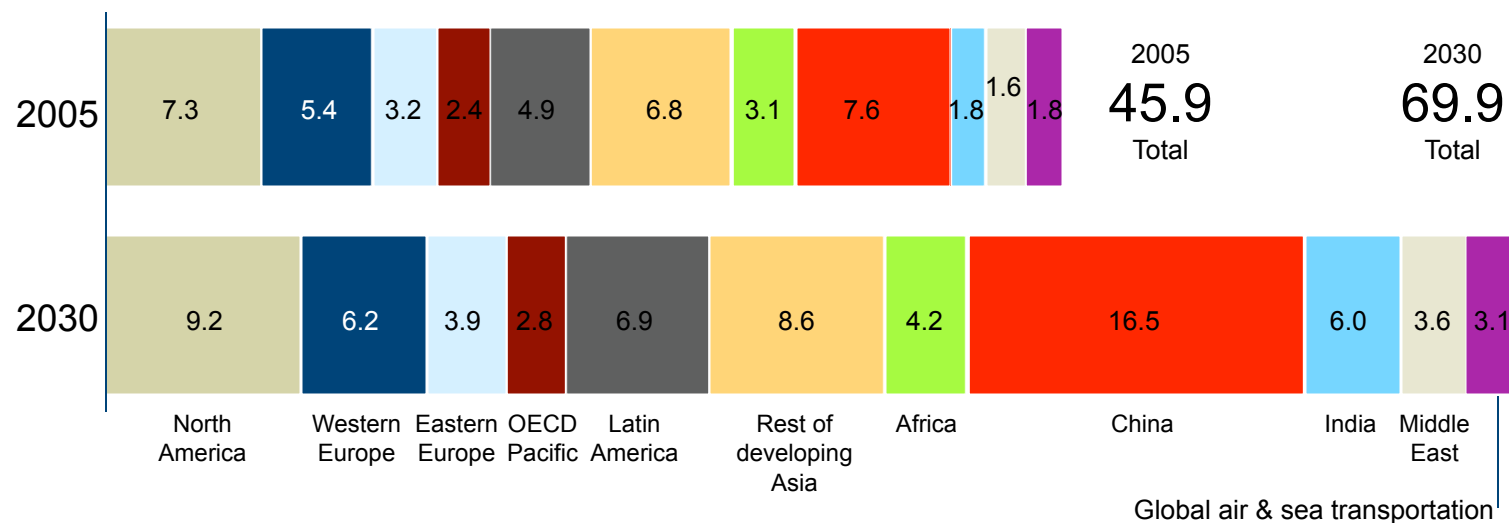


Environmentalists do not count "large hydro schemes" as renewable; eligible renewable includes biomass & waste, geothermal, small hydro, solar and wind

Source: PG&E's power content label projected for 2008 (left), CEC (middle) & EIA (right)

Moving in the wrong direction

GHG emissions, BAU scenario, Gigatonnes of CO2 Equiv.



What will happen unless...

Momentum of energy infrastructure hard to change

